National Innovation System And Culture: A Cross-Country Analysis

Joseph Gogodze

Abstract: This study assesses the relationship between Hofstede's cultural dimensions and the constituents of a National Innovation System (NIS). We consider an NIS as a special kind of intangible (latent) asset and identify its two constituents: input and output capital. These are extracted through a modern NIS measurement model, based on the Global Innovation Index. Using structural equation models, we show that power distance and uncertainty avoidance, and long-term orientation and indulgence vs. restraint, act through the latent constructs PDUA and LTIV, respectively. Moreover, individualism (IDV) and NIS constituents are directly and negatively affected by PDUA. IDV and LTIV directly and positively affect the NIS constituents. Further, the results show that masculinity vs. femininity significantly and negatively affects the NIS input constituent and significantly affects the NIS output constituent, but its impact is negative for high-income countries and positive for non-high income countries.

Index Terms: National innovation system, culture, Hofstede's cultural dimensions, global innovation index, structural equation model

1 Introduction

A culture can be seen as the set of shared attitudes, values, goals, and practices that characterize individuals, institutions, and organizations, as well as formal and informal groups. Culture influences all aspects of a society, and it can affect the innovation capability of a country. This expectation is confirmed by many studies (see a brief literature review in the next section), where the investigation of the relationship between culture and innovation is mostly based on certain specific indicators of innovative activities. On the other hand, the usage of composite indices in the investigation of the culture-innovation relationship allows us to better reflect the multidimensional nature of National Innovation Systems (NISs) and, correspondingly, the culture-innovation relationship. Accordingly, we will focus on this area of research in this study.

1.1 Innovation Capability of a Nation and its Measurement

The OECD/EUROSTAT [1] provides the following definition of innovation: "An innovation is the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization, or external relations" (p. 46). Note also (see Schumpeter [2]) that innovation is only part of the more general process through which new technologies enter the market, which includes three stages: invention, innovation, and adoption. Inventions are usually the product of R&D processes, and represent general ideas that may be commercialized in the innovation stage and then disseminated in the market in the adoption stage. The sequence "invention-innovation-adoption" can function efficiently only in the appropriate enabling environment, namely the country's innovation system. According to Gregersen and Johnson [3], "The main idea of the concept of innovation systems is that the overall innovation performance of an economy depends not only on how specific organizations, like firms and research institutes, perform, but also on how they interact with each other and with the government sector in knowledge production and distribution" (p. 5). Obviously, innovation systems may operate at the regional (sub-national), national, or international level. The innovation capability of a country is determined by its NIS. In other words, an NIS can be seen as a socio-economic system where different actors, such as companies, research and academic organizations, public administrations, technical mediators, and other formal and informal institutions, interact. NISs necessarily exploit all accessible resources in a country, such as human, financial, infrastructural, and institutional resources. Moreover, an NIS requires the generation and dissemination of knowledge, in addition to the utilization of innovation. Finally, the results obtained by NISs can help achieve economic development. An NIS can also be seen as some kind of intangible asset, characterized by a set of interacting, intangible (or latent) components, able to contribute to a country's economic growth, value creation, and wellbeing. At the same time, considering NISs as intangible assets requires an appropriate measurement model. The measurement of an NIS (and, correspondingly, of a country's innovative capabilities) requires the construction of special instruments to address the complex and multidimensional nature of NISs, and adequately reproduce them. Composite indicators are instruments of this type. Recently, various organizations and researchers have accumulated a large deal of experience in building composite indicators for the measurement of a country's innovative capability, such as the index proposed by Porter and Stern [4], ArCo Index[5], Innovation Capability Index [6], TechAchv Index [7], Knowledge Economy Index [8], Global Innovation Scoreboard [9], European Innovation Scoreboard [10] , TechRead Index [11], BCG/NAM Innovation Index [12], Economist Intelligence Unit Index [13], and Summary Innovation Index [14] (for other composite indicators, see [15],[16],[17]). The GII (for further details, see [18]) is used in this study. This index is built on a hierarchical basis and includes two sub-indices (Innovation Input and Innovation Output sub-indices denoted below as Iiput and Ioput, respectively), composed of seven underlying constructs, referred to as pillars. Each pillar is divided into sub-pillars, each of which is composed of individual indicators. Note that our decision to use the GII was based on the following considerations: it relates to the extensive experience of previous studies and consistently reflects the current understanding of NISs and the mechanisms behind their functioning, it uses well-defined measurement tools, both its primary data and final indicators are subject to multiple external and internal tests, and it is published regularly and contains detailed data on more than 100 countries. This study refers to the GII data for the period 2011–2015, at the sub-indices level.

1.2 Hofstede's Cultural Dimensions

Several frameworks have been used to describe a national culture in different types of socio-economic research (e.g.,[19],[20],[21],[22]). In particular, Hofstede's theory of culture and the corresponding indicators [19], despite some criticism (e.g., [23], [24], [25]), have been widely used as proxies of national culture characteristics in the culture-innovation interaction context (see references in the next section). In this study, we refer to Hofstede's theory, as it has successfully passed the test of time, has been widely used in the culture-innovation investigation, and comes with an easily available dataset. According to Hofstede [19], culture is "the collective programming of the mind that distinguishes the members of one group or category of people from another" (p. 9), which operates through a "system of societal norms consisting of the value systems (or mental software) shared by major groups in the population" (p. 11). Further, Hofstede (see [19], [26]) classified countries along the following cultural dimensions/factors/indices: power distance (PDI), uncertainty avoidance (UAI), individualism vs. collectivism (IDV), masculinity vs. femininity (MAS), long-term orientation (LTO), and indulgence vs. restraint (IVR).

1.3 Culture-Innovation Relationship

There seem to be several possible ways for culture to have an impact on innovation. In particular, the PDI dimension may affect innovation through organizational hierarchy, centralized power, formal rules, and resistance to change. The UAI dimension may affect innovation through the necessity of consensus and procedures, which are needed to avoid uncertainty, but inhibit innovation. The IDV dimension may affect innovative capabilities through the restriction of personal freedom and autonomy of decision making, while the MAS dimension may affect innovation capabilities through the constraints on job structuring as well as the acceptance of conflict and competition. Further, the LTO dimension may affect innovation potential through the expectations of future rewards because innovation often breaks traditions, while the IVR dimension may affect innovation capabilities because innovation can change the key human desires related to life enjoyment. Prior publications showed that culture is an important determinant of various aspects of innovation. In particular, Kedia, Keller, and Julian [27] found that a low PDI is a good predictor of productivity in R&D units. Moreover, Shane [28],[29] found that societies with a low PDI are more innovative, as a low PDI is positively related to higher innovative capacities, while Mumford and Licuanan [30] showed that employees have more innovative attitudes in a social environment with a low PDI. Efrat [31] showed that PDI has a negative impact on innovation investment, while investment in innovation is positively correlated with innovation outputs. In addition, Kedia, Keller, and Julian [27] found that UAI is not a strong predictor of productivity in R&D units, and Shane [29] found that a weak UAI is positively related to higher innovative capacities. Van Evergingen and Waarts [32] showed that cultures with a strong UAI are more resistant to innovation, while Efrat [31] found that UAI has a negative impact on innovation outputs, and that UAI alone has a negative influence on all aspects of innovation output, but a positive impact when combined with either IDV or MAS. Further, Shane [29] found that a high IDV is positively related to a higher innovative capacity, while Morris, Davis, and Allen [33] found that excessive individualism or collectivism might inhibit entrepreneurship and innovation. Nakata and Sivakumar [34] noted that individualism facilitates innovation initiation and collectivism supports innovation implementation, and Efrat [31] showed the existence of an impact of IDV and MAS on innovation outputs. Kedia, Keller, and Julian [27] found that a high MAS is a good predictor of productivity in R&D units, while Shane [29] found that a low MAS has no explanatory power for innovation. Unlike the PDI, IDV, UAI, and MAS dimensions, Hofstede's "new" dimensions, LTO and IVR, have not been fully investigated yet in the context of their relation with innovation activities. To the best of our knowledge, only Nakata and Sivakumar [34] have addressed the links between LTO and innovation, and argued that this dimension is important in a new product development process. On the other hand, to our knowledge, no publication has yet considered the relationship between the IVR dimension and innovation. Recently, the literature has shown a tendency to use a variety of innovative indices in the investigation of culture-innovation interactions (see [35] , [36] ,[37] , [38], [39]). The approach associated with the use of innovation indices seems very effective, as it allows us to fully embrace the multidimensional nature of NISs. Further, the investigation of the culture-innovation relationship, with regard to various theories of culture, seems very relevant too. In this study, we use the GII and Hofstede's cultural dimensions to investigate such a relationship.

1.4 Theoretical Assumptions and Aims of Study

The abovementioned considerations allow us to offer the following definition. An NIS is an intangible (latent) asset (capital) of a country and represents the resources and/or values of its actors, and the current and potential sources for future economic growth, value creation, and wellbeing of a country. Based on the measurement method used for the GII, in this study, we also argue that all NISs present two constituent components (their names are rather conventional, they are chosen to indicate the corresponding GII constructs, and they correspond to two sub-indices of the GII): NIS income capital (INC) and NIS output capital (OUC). These constituent components should also be considered two different types of intangible assets. We propose to understand them as hidden values of the corresponding NIS's actors, and the current and potential sources for a country's future development. INC and OUC (indirectly) are measured by the corresponding GII constructs, Iiput and Ioput, respectively. In particular, INC is linked with some characteristics of NISs such as political and regulatory environment, education, R&D, and innovation linkages. On the other hand, OUC is linked with characteristics like knowledge creation and diffusion, and creative goods and services. This study is also based on a set of assumptions regarding Hofstede's cultural dimensions. We argue that the pairs of Hofstede's dimensions PDI/UAI and LTO/IVR are determined (or are represented) by two latent independent essences/constructs, PDUA and LTIV, respectively. Moreover, we assume that Hofstede's MAS dimension is independent, but that the IDV dimension is directly affected by the PDUA construct (which can be seen as a restrictor or limiter of individualism). We neither provide a theory regarding PDUA and LTIV, nor call them by special names, as it seems premature at this stage. Note only that the PDUA construct may be conveniently understood as an element reflecting the attitude toward "taking responsibility," and the LTIV construct as an element reflecting the attitude toward relations of the type "today egg–tomorrow chicken." Further, the abovementioned assumptions regarding Hofstede's cultural dimensions are based on a preliminary data analysis. It can be noted that the pairs PDI/UAI and LTO/IVR are the one-dimensional blocks of the indicators (in the sense of the principal component analysis), and that IDV is noticeably correlated with the PDI/UAI dimensions. Based on the above considerations, this study develops and explores a conceptual framework for the relationship between Hofstede's cultural dimensions and an NIS's components, as presented in Annex Fig. 1. In particular, each arrow in Annex Fig. 1 represents a research hypothesis that will be tested in this study.

2 Methods

2.1 Data

The GII (see [18]) is built on a hierarchical basis and includes two sub-indices: Innovation Input (Iiput), which is the composite of five input indices (pillars), and Innovation Output (Ioput), which is the composite of two output indices. Each pillar is divided into sub-pillars, each of which is built using a number of relevant individual indicators. In this study, we refer to the values of the GII pillars for the period 2011–2015 (GII sample, henceforth). The GII is the simple average of its Input and Output sub-indices. Moreover, sub-indices are the simple average of their underlying pillar scores. Each pillar score is calculated as the weighted average of its sub-pillar scores, and each sub-pillar score is calculated as the weighted average of its individual indicators. Individual indicators[1] are obtained from various sources and scaled to be comparable across countries through a division by the relevant scaling factor. Individual indicators are also normalized to the [0, 100] range, with higher scores representing better outcomes. Such normalization was obtained through the min-max method. Each year, the most recent value is used for each individual indicator. Details about individual indicators' composition, data sources, processing techniques, and country selection methods can be obtained in [18]. The dataset of Hofstede's cultural dimensions is obtained from [40], where all details of the data collection and processing methods are also explained. In this study, we refer to a dataset of Hofstede's cultural dimensions that score into the [0, 100] range, and include the PDI, IND, MAS, and UAI scores for 69 countries, LTO scores for 63 countries, and IVR scores for 62 countries. Matching the set of countries in the GII sample with all available scores of Hofstede's cultural dimensions, we end up with a sample of 60 countries for 2011, and 61 countries for the period 2012–2015 (CGII sample, henceforth). We also use the World Bank classification of countries by income group, as it is presented in the abovementioned GII publications. The distribution of countries by income groups in the CGII sample is presented in Annex Table 1. Based on the World Bank classification, we use the following classification: "High income" countries (also classified as High income countries by the World Bank) and "non-High income" countries (including Low income, Lower Middle income, and Upper Middle income countries). In addition, sub-samples of the CGII sample belonging to High income and non-High income countries are named H-sample and nH-sample, respectively.

2.2 Analytical Procedures

We used the structural equation model (SEM) analysis to assess the direct and indirect relationships among the components of an NIS. The main purpose of the SEM is to simultaneously explain the pattern of a series of interrelated dependence relationships among a set of latent (or unobserved) variables, measured using manifest (or observed) variables. Therefore, the SEM involves two stages of modeling: first, describing and testing the measurement model and, second, describing and analyzing the structural model. There are two different techniques to perform SEM analyses, known as variance- and covariance-based SEM. In this study, a variance-based partial least squares (PLS) method was used to evaluate the proposed theoretical model because it has the capacity to deal with complex models with a high number of variables and relationships, allows for working with small sample sizes, makes less strict assumptions about the variable distributions, and is primarily intended for the causal-predictive analysis of models without any existing strong theory (e.g. [41] ,[42],[43]). The SmartPLS software, [44], was used in this study to perform the SEM analysis. To assess the significance of different statistical characteristics, a bootstrap analysis was performed in the SmartPLS framework, and was based on no less than 5,000 sampling generations, to obtain the final statistical estimations. To investigate the homogeneity of the various groups of data, the SmartPLS procedure for multi-group analyses was used. To estimate the minimum sample size, the software G*Power 3.1.9,[45], was used in this study.[2] Our estimates show that the minimum sample size to evaluate the model presented in Annex Figure 1 is 92. In this study, we also use the threshold values (or rules of thumb) for both Pearson's coefficient, R^2, and Cohen's indicator, f^2, usually employed in standard practice[3] (see e.g. [46]).

3 Results

As previously mentioned, Annex Table 1 shows the descriptive statistics and correlations for the complete sample, as well as for the H and nH samples, for all variables introduced in this study. Thus, as expected, Annex Table 2 shows statistically significant differences in the characteristics of the H and nH samples. Thus, a separate consideration of the H and nH samples seems necessary, which we will address below. The results, relative to the standardized path coefficients (or β coefficients) and outer weights estimation for the considered model, are reported in Annex Tables 3 and 4. In Annex Table 3, all path coefficients for the complete sample are statistically significant at the 5% level and have the expected sign. On the other hand, for the H sample, the phases IDV→INC, LTIV→OUC, MAS→INC, and PDUA→OUC show no statistically significant effect, while all other phases have a statistically significant effect at the 1% level and show the expected sign. For the nH sample, the phases IDV→OUC, PDUA→INC, and PDUA→OUC show no significant effect, and all other phases have statistically significant effects at the 5% level. Note also that all phases, except MAS→OUC, have the expected sign for the nH sample. Annex Table 4 shows that only the outer weight UAI→PDUA for the nH sample has no statistically significant effect. The explained variance (or Pearson's coefficient, R^2) for the dependent variables is a key indicator of the quality of a model. On the other hand, the effect size (or Cohen's indicator, f^2) assesses the magnitude/strength of the relationship between certain variables of interest, and shows how much an exogenous latent variable contributes to an endogenous variable's R^2; therefore, it is also a key indicator of the quality of a model. The estimated values of R^2 for the dependent variables and f^2 for the phases used in the considered model are shown in Annex Table 5. For all endogenous variables, a large portion of the variance is explained ($R^2 > 0.26$) in the complete sample. Moreover, Annex Table 5 shows the following results for the complete sample: phases PDUA→OUC, MAS→INC, and MAS→OUC have a negligible ($f^2 < 0.02$) and statistically insignificant effect; phases IDV→OUC and PDUA→INC have a small effect ($0.02 < f^2 < 0.15$); phases LTIV→INC, LTIV→INC, and LTIV→OUC have a medium effect ($0.15 < f^2 < 0.35$); and phases INC→OUC and PDUA→IDV have a large effect ($0.35 < f^2$). For details regarding the H and nH samples, see Annex Table 5. To further investigate the features of both High and non-High income countries, we carry out a comparison of the path coefficients for the H and nH samples (see Annex Table 6). The differences between the path coefficients for the H and nH samples are statistically significant at last at the 10% level for the following phases: MAS→INC, MAS→OUC, PDUA→INC, IDV→INC, IDV→OUC, and LTIV→OUC (i.e., for six of the 10 phases). Let us now consider the issue of homogeneity across time, a basic assumption of this study. To this end, we split the H and nH samples into smaller sub-samples, by year, and conduct the relevant comparisons for the phase coefficients in each sub-sample, and for the H and nH samples, respectively. The results show (see Annex Table 7) that only phase difference MAS→OUC (nH vs. nH-2015) is significant at the $p < 0.1$ level. Hence, our assumption of homogeneity across time seems acceptable. The results of the statistical analysis allow us to conclude that the proposed model has a satisfactory quality and, in general, it relevantly displays the direction and magnitude of the interactions among the considered variables.

4 Discussion

Our findings relate to two different dimensions. On the one hand, they are related to Hofstede's cultural dimensions and, on the other hand, they refer to interactions between these dimensions and the NIS's constituent components INC and OUC, which correspond to the input and output components of an NIS, respectively. As for the first dimension of our results, we show that the pairs of Hofstede's dimensions PDI/UAI and LTO/IVR are determined (or represented) by two latent independent constructs, PDUA and LTIV, respectively. We demonstrate that Hofstede's cultural dimension IDV is directly and negatively affected by PDUA and, therefore, PDUA can be seen as a restrictor/limiter of individualism. This finding is in line with the results of Sun [39], where an indirect impact of PDI and UAI through IDV on the Porter-Stern innovation index,[4] , was demonstrated. Moreover, we find that the magnitude of the interaction between PDUA and IDV depends on the level of economic development. Further, the construct LTIV, as defined in this study, does not seem to have been considered in earlier literature. As for the second dimension of the results of this study, our findings generally confirm the results of previous investigation (e.g., [28],[29],,[31],[33],[34],[36],[39]), and address the research subject in a new fashion. In particular, the results of our analysis indicate that Hofstede's dimension IDV is significantly and positively affected by both NIS input and output components (and, therefore, by the whole NIS). We show that the magnitude of the interactions between IDV and the NIS input and output components depends on the level of a country's economic development. In addition, our analysis shows that MAS significantly and negatively affects the NIS input component. On the other hand, it also significantly affects the NIS output component, but its impact is negative for High-income countries and positive for non-High income countries. Moreover, the results of our analysis indicate that Hofstede's dimensions PDI and UAI have a double impact on the NIS input and output components: through the latent construct PDUA and through the phase PDUA→IDV, where PDUA has a significant and negative impact on both considered NIS components. Note that the magnitude of PDUA's impact on an NIS depends on the level of economic development of a country. Further, our analysis indicates that LTO and IVR have no direct impact on the NIS input and output components, but that their impact goes through the construct LTIV. Note also that LTIV has a significant and positive impact on both considered NIS components, the magnitude of which depends on the level of economic development of a country. To summarize the considerations reported above and for a more detailed presentation of the results of this study, please refer to Annex Table 8, where the assessments of the total effects of the interactions among the variables are presented.

5 Conclusion

This study proposes the consideration of an NIS as a special kind of intangible asset, and identifies its two key constituent components, which are extracted on the basis of a modern NIS measurement model, the GII, and have been conventionally named INC and OUC. Based on the empirical observation and applying the SEM techniques, this study establishes the existence of a causal relationship between the abovementioned NIS constituent components and Hofstede's cultural dimensions. An assessment of the magnitude of such interactions has also been provided. Of course, as with any study of socio-cultural phenomena, ours is not without limitations. Obviously, the main limitation is the small number of countries with available data. Moreover, studies based on other models of culture should be conducted. Nevertheless, the results of this study present additional sufficiently rigorous empirical evidence of the close relationship between culture and an NIS. In addition, the results of this study point toward future research providing a detailed analysis of the link between cultural characteristics and the constituent components of NISs, as well as a more detailed examination of the dependence of such links on the different characteristics of economic development; these topics would be of great academic and practical relevance. More generally, the results of such studies, regarding the interaction between NISs and the culture may help develop new management capabilities of NISs, considering the cultural features of a country. We hope that the proposed model, as well as its parameter assessments, may enable researchers and practitioners to rank the relative importance of different actions to enhance the effectiveness of NISs.

Footnotes

1. Their number and composition change from year to year, and they add up to 79–84 in the period 2011–2015.
2. We based our estimations on the following parameters: the test power p = 0.8, Cohen's indicator f^2 = 0.15, significance level α = 0. 05, and maximum number of predictors N = 5 (see Annex, Fig. 1).
3. $R^2 < 0.02$ (negligible), $0.02 < R^2 < 0.13$ (weak), $0.13 < R^2 < 0.26$ (medium), and $R^2 > 0.26$ (large); $f^2 < 0.02$ (negligible), $0.02 < f^2 < 0.15$ (small), $0.15 < f^2 < 0.35$ (medium), and $f^2 > 0.35$ (large).

References

[1] OECD/EUROSTAT. (2005). The measurement of scientific and technological activities. Oslo manual (3rd ed.). Paris: OECD Publishing.

[2] Schumpeter, J. A. (1942). Capitalism, socialism, and democracy. London: Allen & Unwin.

[3] Gregersen, B., & Johnson, B. (1997). How do innovations affect economic growth? Some different approaches in economics. Report within the ISE Innovation Systems and European Integration. Aalborg, Denmark: Aalborg University, Department of Business Studies.

[4] Porter, M. E., & Stern, S. (2001). Innovation: location matters. MIT Sloan Management Review, 42(4), 28–37.

[5] Archibugi, D., & Coco, A. (2004). New indicator of technological capabilities for developed and developing countries (ArCo). World Development, 32(4), 629–654.

[6] UNCTAD. (2005). World investment report. Transnational corporations and the internationalization of R&D. Geneva: UNCTAD Publishing.

[7] UNIDO. (2005). Industrial development report. Capability building for catching-up. Historical, empirical and policy dimensions. Vienna: UNIDO Publishing.

[8] Chen, D., & Dahlman, C. (2005). The Knowledge Economy, the KAM Methodology and World Bank Operations. World Bank Institute Working Paper No. 37256, World Bank, Washington DC.

[9] European Commission. (2007). Global innovation scoreboard 2006. Brussels: Directorate-General for Enterprise and Industry.

[10] European Commission. (2008). European innovation scoreboard 2007. Brussels: Directorate-General for Enterprise and Industry.

[11] World Economic Forum (WEF). (2009). The global competitiveness report 2009–2010. Geneva: WEF.

[12] Boston Consulting Group/National Association of Manufacturers. (2009). The innovation imperative in manufacturing: How the United States can restore its edge. Boston: BCG. Retrieved from: http://www.bcg.com/documents/file15445.pdf.

[13] Economist Intelligence Unit (EIU). (2009). A new ranking of the world's most innovative countries. An Economist Intelligence Unit report sponsored by Cisco. Retrieved from: http://graphics.eiu.com/PDF/CiscoInnovation_Complete.pdf.

[14] INNO Metrics. (2011). Innovation union scoreboard 2010. Maastricht: UNU-MERIT.

[15] Archibugi, D., & Coco, A. (2005). Measuring technological capabilities at the country level: A survey and a menu for choice. Research Policy, 34(2), 175–194.

[16] Archibugi, D., Denni, M., & Filippetti, A. (2009). The technological capabilities of nations: The state of the art of synthetic indicators. Technological Forecasting and Social Change, 76(7), 917–931.

[17] Gogodze, J. (2013). The composite ECAICI: Positioning of Georgia's innovative capacities in the Europe-Central Asia region. International Journal of Scientific & Technology Research, 2(9), 110–119.

[18] INSEAD. Global innovation index 2011; Global innovation index 2012;. Global innovation index 2013; Global innovation index 2014; Global innovation index 2015. Fontainebleau: INSEAD.

[19] Hofstede, G. (2001). Culture's consequences: Comparing values, behaviors, institutions and organizations across nations (2nd ed.). Thousand Oaks, CA: SAGE Publications.

[20] House, R. J. (2004). Culture, leadership, and organizations: The GLOBE study of 62 societies. Thousand Oaks, CA: SAGE publications.

[21] Schwartz, S. H. (2006). A theory of cultural value orientations: Explication and applications. Comparative Sociology, 5(2–3), 137–182.

[22] Trompenaars, F., & Hampden-Turner, C. (2012).

Riding the waves of culture: Understanding cultural diversity in business (3rd ed.). Boston, MA: Nicholas Brealey Publishing.

[23] Baskerville, R. F. (2003). Hofstede never studied culture. Accounting, Organizations and Society, 28(1), 1–14.

[24] Dorfman, P. W., & Howell, J. P. (1988). Dimensions of national culture and effective leadership patterns: Hofstede revisited. Advances in International Comparative Management, 3, 127–150.

[25] Jones, M. (2007). Hofstede – Culturally questionable? Paper presented at the Oxford Business & Economics Conference, Oxford, UK. Retrieved from: http://ro.uow.edu.au/cgi/viewcontent.cgi?article = 1389&context = commpapers.

[26] Hofstede, G., Hofstede, G. J., & Minkov, M. (2010). Cultures and organizations: Software of the mind (3rd ed.). New York: McGraw-Hill.

[27] Kedia, B. L., Keller, R. T., & Julian, S. T. (1992). Dimensions of national culture and the productivity of R&D units. Journal of High Technology Management, 3(1), 1–18.

[28] Shane, S. (1992). Why do some societies invent more than others? Journal of Business Venturing, 7(1), 29–46.

[29] Shane, S. (1993). Cultural influences on national rates of innovation. Journal of Business Venturing, 8(1), 59–73.

[30] Mumford, M. D., & Licuanan, B. (2004). Leading for innovation: Conclusions, issues, and directions. Leadership Quarterly, 15(1), 163–171.

[31] Efrat, K. (2014). The direct and indirect impact of culture on innovation. Technovation, 34(12), 12–20.

[32] Van Everdingen, Y. M., & Waarts, E. (2003). The effect of national culture on the adoption of innovations. Marketing Letters, 14(3), 217–232.

[33] Morris, M. H., Davis, D. L., & Allen, J. W. (1994). Fostering corporate entrepreneurship: Cross-cultural comparisons of the importance of individualism and collectivism. Journal of International Business Studies, 25(1), 65–89

[34] Nakata, C., & Sivakumar, K. (1996). National culture and new product development: An integrative review. Journal of Marketing, 60(1), 61–72.

[35] Deckert, C., Scherer, A., & Guillén, V. I. N. (2015). Cultural impacts on national innovativeness, Cologne Business School Working Paper 2015 No. 01. Retrieved from: http://www.cbs.de/fileadmin/cbs/pdf/Forschung/CBS_Working_Paper_Series/WP_CultInno_08102015v02.pdf

[36] Rinne, T., Steel, G. D., & Fairweather, J. (2012). Hofstede and Shane revisited the role of power distance and individualism in national-level innovation success. Cross-Cultural Research, 46(2), 91–108.

[37] Rossberger, R., & Krause, D. (2012). National culture, heterogeneity and innovation: New insights into the relationship between the GLOBE dimensions and national level innovation. GSTF International Journal of Law and Social Sciences, 2(1), 84–89.

[38] Strychalska-Rudzewicz, A. (2015). Cultural dimensions and innovation. Socio-Economic Problems and the State, 13(2), 59–67.

[39] Sun, H. (2009). A meta-analysis on the influence of national culture on innovation capability. International Journal of Entrepreneurship and Innovation Management, 3/4(10), 353–360.

[40] Hofstede, G. (2015). National cultural dimensions. Retrieved from: www.geert-hofstede.com

[41] Esposito Vinzi, V., Trinchera, L., & Amato, S. (2010). PLS path modeling: From foundations to recent developments and open issues for model assessment and improvement. In V. Esposito Vinzi, W.W. Chin, J. Henseler, & H. Wang (Eds.), Handbook of partial least squares: Concepts, methods and applications (pp. 47–82). Berlin, Germany: Springer Berlin Heidelberg.

[42] Hwang, H., Malhotra, N. K., Kim, Y., Tomiuk, M. A., & Hong, S. (2010). A comparative study on parameter recovery of three approaches to structural equation modeling. Journal of Marketing Research, 47(4), 699–712.

[43] Wong, K. K. (2010). Handling small survey sample size and skewed dataset with partial least square path modelling. Vue: The Magazine of the Marketing Research and Intelligence Association, 20–23.

[44] Ringle, C. M., Wende, S., & Becker, J. M. (2015). SmartPLS 3. Boenningstedt: SmartPLS GmbH. Retrieved from: www.smartpls.com.

[45] Faul, F., Erdfelder, E., Lang, A. G., & Buchner, A. (2007). G*Power 3: A flexible statistical power analysis program for the social, behavioral,

[46] Hair, J. F., Hult, T. M., Ringle, C. M., & Sarstedt, M. A. (2014). Primer on partial least squares structural equation modeling (PLS-SEM). Los Angeles, CA:

SAGE publications.

Annex

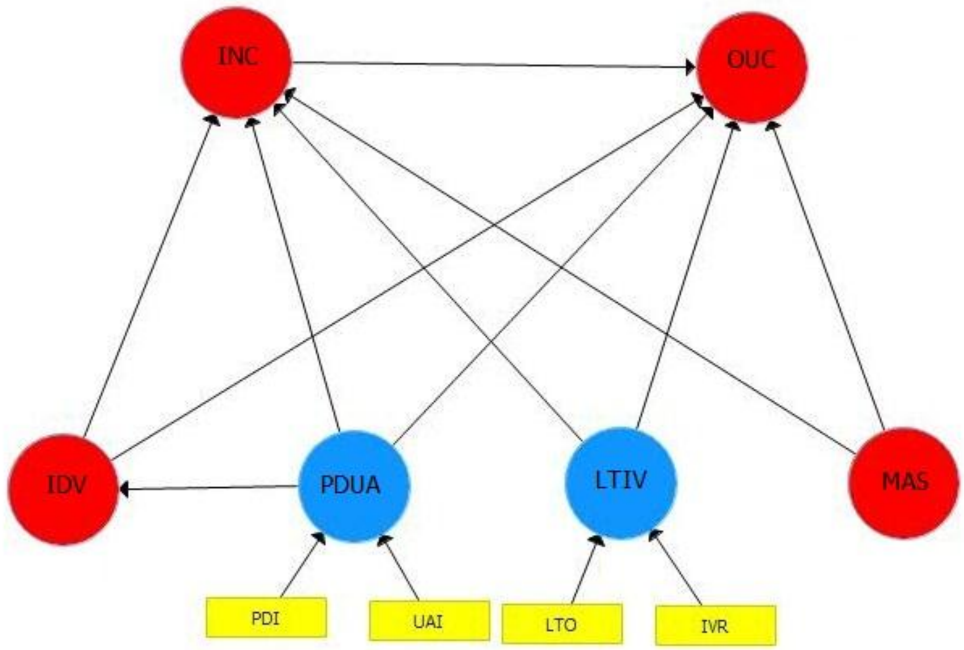

Fig. 1. *Conceptual model of NIS input-output components and interaction with Hofstede's cultural dimensions*
Note: *INC = Iiput and OUC = Ioput; for variable descriptions, see text.*

Table 1
CGII Samples by Year

Year	Number of countries by income level				Total
	H	UM	LM	L	
2011	33	19	7	1	60
2012	34	19	7	1	61
2013	34	19	7	1	61
2014	38	15	7	1	61
2015	38	15	7	1	61

Note: *H = High income countries; UM = Upper Middle income countries; LM = Lower Middle income countries; L = Low income countries.*

Table 2.
Descriptive Statistics and Correlations

Variable	M	STDEV	STERR	Correlation Matrix							
				Ioput	Iiput	PDI	IDV	MAS	UAI	LTO	IVR
				Complete sample (N = 304)							
Ioput	38.99	10.59	0.61	1.00							
Iiput	50.30	12.17	0.70	0.87***	1.00						
PDI	58.50	20.42	1.17	-0.57***	-0.59***	1.00					
IDV	46.19	23.45	1.35	0.64***	0.64***	-0.66***	1.00				
MAS	49.02	19.89	1.14	-0.09	-0.08	0.15***	0.03	1.00			
UAI	66.51	22.64	1.30	-0.35***	-0.35***	0.21***	-0.19***	0.03	1.00		
LTO	49.04	22.26	1.28	0.42***	0.32***	0.03	0.13**	0.02	-0.03	1.00	
IVR	47.44	22.41	1.29	0.16***	0.21***	-0.30***	0.16***	0.08	-0.07	-0.53***	1.00
				H sample (N = 177)							
Ioput	44.93	8.84	0.66	1.00							
Iiput	58.24	8.41	0.63	0.78***	1.00						

PDI	49.20	19.13	1.44	-0.51***	-0.45***	1.00					
IDV	57.69	21.69	1.63	0.48***	0.37***	-0.55***	1.00				
MAS	49.36	23.16	1.74	-0.16**	-0.09	0.15**	0.08	1.00			
UAI	64.54	23.95	1.80	-0.44***	-0.65***	0.39***	-0.26***	0.10	1.00		
LTO	54.30	21.47	1.61	0.20***	0.08	0.30***	-0.14*	0.15**	0.18**	1.00	
IVR	49.94	18.77	1.41	0.34***	0.33***	-0.57***	0.38***	-0.09	-0.34	-0.55***	1.00
					nH sample (N = 127)						
Ioput	30.70	6.46	0.57	1.00							
Iiput	39.23	6.74	0.60	0.70***	1.00						
PDI	71.46	14.17	1.26	0.08	-0.01	1.00					
IDV	30.15	14.85	1.32	0.25***	0.34***	-0.39***	1.00				
MAS	48.55	14.19	1.26	-0.10	-0.32***	0.33***	-0.17*	1.00			
UAI	69.25	20.45	1.81	-0.22**	0.04	-0.25***	0.05	-0.15*	1.00		
LTO	41.71	21.31	1.89	0.58***	0.30***	0.09	0.17*	-0.28***	-0.29***	1.00	
IVR	43.96	26.35	2.34	-0.20**	-0.02	0.08	-0.28	0.36***	0.27***	-0.66***	1.00

Note: **** = p < 0.01; ** = p < 0.05, * = p < 0.1; M = mean; STDEV = standard deviation; STERR = standard error; for variable descriptions, see text.*

Table 3.
Estimation of Standardized Path Coefficients

Phase	Complete sample			H sample			nH sample		
	β	STDEV	T	B	STDEV	T	β	STDEV	T
IDV→INC	0.327	0.060	5.512***	0.033	0.122	0.280	0.338	0.094	3.744***
IDV→OUC	0.143	0.035	4.130***	0.210	0.048	4.406***	0.061	0.064	0.895
INC→OUC	0.595	0.035	17.100***	0.588	0.045	13.276***	0.573	0.059	9.705***
LTIV→INC	0.378	0.041	9.151***	0.252	0.057	4.297***	0.301	0.083	3.544***
LTIV→OUC	0.243	0.031	7.882***	0.261	0.049	5.303	0.421	0.066	6.486***
MAS→INC	-0.079	0.030	2.651***	-0.020	0.053	0.382	-0.277	0.078	3.450***
MAS→OUC	-0.061	0.026	2.332**	-0.134	0.037	3.600***	0.160	0.070	2.374**
PDUA→IDV	-0.650	0.029	22.410***	-0.496	0.051	9.823***	-0.371	0.135	2.891***
PDUA→INC	-0.308	0.046	6.690***	-0.542	0.094	5.787***	0.163	0.120	1.459
PDUA→OUC	-0.078	0.033	2.379**	0.029	0.054	0.636	-0.011	0.078	0.214

Note: **** = p < 0.01; ** = p < 0.05; * = p < 0.1; STDEV = standard deviation; T = t-statistics.*

Table 4.
Outer Weights Estimation

Phase	Complete sample			H sample			nH sample		
	M	STDEV	T	M	STDEV	T	M	STDEV	T
IVR →LTIV	0.903	0.073	12.463*	1.135	0.072	15.987*	0.595	0.182	3.276**
LTO→ LTIV	1.114	0.063	17.682*	0.913	0.131	6.993*	1.272	0.066	19.405*
PDI→PDUA	0.906	0.026	34.719*	0.643	0.052	12.411*	0.915	0.275	3.651*
UAI→PDUA	0.272	0.056	4.890*	0.555	0.057	9.746*	0.026	0.317	0.066

Note: **** = p < 0.01; ** = p < 0.05; * = p < 0.1; M = mean; STDEV = standard deviation; T = t-statistics.*

Table 5.
Assessments of Variance Explained and Effect Size

Variables and Phase	Complete sample			H sample			nH sample		
	MQI	STDEV	T	MQI	STDEV	T	MQI	STDEV	T
Variable				Variance explained (MQI = R^2)					
IDV	0.424	0.038	11.249***	0.248	0.050	4.964***	0.156	0.069	2.209**

INC	0.618	0.036	17.254***	0.500	0.054	8.850***	0.340	0.066	4.781***
OUC	0.817	0.017	47.789***	0.719	0.039	18.147***	0.679	0.048	13.941***
Phase	**Effect size (MQI = f^2)**								
IDV→INC	0.162	0.068	2.240**	0.023	0.034	0.047	0.153	0.085	1.751*
IDV→OUC	0.057	0.029	1.851*	0.119	0.061	1.849*	0.017	0.022	0.327
INC→OUC	0.748	0.129	5.752***	0.637	0.173	3.702***	0.690	0.168	4.045***
LTIV→INC	0.340	0.084	3.908***	0.112	0.053	1.794*	0.135	0.077	1.518
LTIV → OUC	0.220	0.059	3.617***	0.189	0.074	2.419**	0.459	0.182	2.497**
MAS → INC	0.018	0.013	1.177	0.006	0.009	0.085	0.102	0.055	1.660*
MAS →OUC	0.023	0.018	1.066	0.065	0.036	1.642	0.071	0.056	1.177
PDUA→IDV	0.743	0.115	6.383***	0.336	0.090	3.631***	0.193	0.101	1.788*
PDUA →INC	0.136	0.036	3.645***	0.402	0.163	2.298**	0.046	0.045	0.732
PDUA→OUC	0.019	0.015	1.097	0.006	0.009	0.219	0.014	0.023	0.026

Note: **** = $p < 0.01$; ** = $p < 0.05$; * = $p < 0.1$; MQI = model quality index; STDEV = standard deviation; T = t-statistics.*

Table 6.

Phase Differences Comparison for H and nH Samples

Phase	**Phase difference**	**T-value**	
		Parametric test	**Welch-Satterthwaite test**
IDV→INC	0.316	1.954*	2.076*
IDV→OUC	0.156**	1.973**	1.954*
INC→OUC	0.018	0.243	0.237
LTIV→INC	0.051	0.524	0.503
LTIV→OUC	0.170	2.153**	2.095**
MAS→INC	0.250***	2.810***	2.692***
MAS→OUC	0.302	4.089***	3.809***
PDUA→IDV	0.105	0.794	0.709
PDUA→INC	0.718	4.874***	4.781***
PDUA→OUC	0.051	0.556	0.537

Note: **** = $p < 0.01$; ** = $p < 0.05$; * = $p < 0.1$.*

Table 7.

Phase Differences Comparison for Sub-Samples Across Time

H vs.	**H-2011**	**H-2012**	**H-2013**	**H-2014**	**H-2015**
IDV → INC	0.081	0. 010	0.028	0.020	0.055
IDV→OUC	0.006	0.031	0.060	0.070	0.051
INC→OUC	0.036	0.037	0.108	0.045	0.003
LTIV→ INC	0.013	0.026	0.045	0.013	0.032
LTIV → OUC	0.072	0.059	0.017	0.003	0.006
MAS →INC	0.010	0.092	0.079	0.068	0.074
MAS → OUC	0.052	0.071	0.007	0.014	0.078
PDUA → IDV	0.041	0.032	0.028	0.036	0.038
PDUA→ INC	0.057	0.001	0.036	0.012	0.034
PDUA → OUC	0.025	0.019	0.032	0.061	0.072
nH vs.	**nH-2011**	**nH-2012**	**nH-2013**	**nH-2014**	**nH-2015**
IDV → INC	0. 189	0.105	0.073	0.107	0.087
IDV→OUC	0.005	0.055	0.029	0.095	0.055

INC→OUC	0.066	0.019	0.209	0.073	0.092
LTIV→ INC	0.002	0.125	0.021	0.013	0.031
LTIV → OUC	0.056	0.076	0.156	0.155	0.004
MAS →INC	0.176	0.207	0.135	0.075	0.096
MAS → OUC	0.244	0.020	0.135	0.107	0.211*
PDUA → IDV	0.014	0.016	0.011	0.022	0.025
PDUA→ INC	0.066	0.069	0.023	0.017	0.003
PDUA → OUC	0.148	0.050	0.009	0.026	0.045

Note: ** = p < 0.1.*

Table 8.
Total Effects of Interactions

Phase	**Complete sample**			**H sample**			**nH sample**		
	M	**STDEV**	**T**	**M**	**STDEV**	**T**	**M**	**STDEV**	**T**
IDV→INC	0.327	0.060	5.512***	0.033	0.122	0.280	0.338	0.094	3.744***
IDV→ OUC	0.339	0.044	7.733***	0.230	0.084	2.783***	0.256	0.078	3.288***
INC→OUC	0.595	0.035	17.100***	0.588	0.045	13.276***	0.573	0.059	9.705***
LTIV→INC	0.378	0.041	9.151***	0.252	0.057	4.297***	0.301	0.083	3.544***
LTIV→ OUC	0.468	0.035	13.520***	0.408	0.054	7.393***	0.592	0.075	7.936***
MAS→INC	-0.079	0.030	2.651***	-0.020	0.053	0.382	-0.277	0.078	3.450***
MAS→OUC	-0.108	0.032	3.349***	-0.146	0.048	3.043***	-0.001	0.080	0.153
PDUA→IDV	-0.650	0.029	22.410***	-0.496	0.051	9.823***	-0.371	0.135	2.891***
PDUA→INC	-0.521	0.035	14.776***	-0.558	0.050	11.237***	0.033	0.114	0.333
PDUA→OUC	-0.481	0.034	14.005***	-0.403	0.049	8.193***	-0.012	0.096	0.179

Note: **** = p < 0.01; M = mean; STDEV = standard deviation; T = t-statistics.*